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## **Corrective Measures Study Report**

Britannia East Grand  
450 - 660 East Grand Avenue  
South San Francisco, California

*Prepared for:*

**Slough SSF, LLC**

Oyster Point Boulevard  
South San Francisco, California 94080

May 25, 2006

Project No. 6206.000

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Geomatrix



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May 25, 2006  
Project 6206.000

Amber Harmon  
Hazardous Substances Engineer  
Department of Toxic Substances Control (DTSC)  
Standardized Permitting and Corrective Action  
700 Heinz Ave, Suite 200  
Berkeley, California 94710

Subject: Corrective Measures Study Report  
Britannia East Grand  
(Former Fuller O'Brien Facility)  
450-660 East Grand Avenue  
South San Francisco, California

Dear Ms. Harmon:

Please find enclosed three copies of the Corrective Measures Study Report for the Britannia East Grand (Former Fuller O'Brien) facility. This report summarizes the *Methane Mitigation Plan, Britannia East Grand Development, Phase II* report written by GeoSyntec Consultants and the *Land Use Covenant Implementation and Enforcement Plan* by DTSC.

Please do not hesitate to contact me if you have any questions or require additional information.

Sincerely yours,

GEOMATRIX CONSULTANTS, INC.

//Original Signed By//

Martin B. Bloes  
Senior Scientist

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cc: Jon Bergschneider, Slough Estates USA Inc.  
Bruce Heimbach, Project Management Advisors, Inc.  
Tom Graf, GrafCon

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## **Corrective Measures Study Report**

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*Prepared for:*

**Slough SSF, LLC**

Oyster Point Boulevard  
South San Francisco, California 94080

*Prepared by:*

**Geomatrix Consultants, Inc.**

2101 Webster Street, 12th Floor  
Oakland, California 94612

May 25, 2006

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## **CORRECTIVE MEASURES STUDY REPORT**

Britannia East Grand  
(Former Fuller O'Brien Facility)  
450-660 East Grand Avenue  
South San Francisco, California

### **1.0 INTRODUCTION**

This Corrective Measures Study Report summarizes the following documents prepared for implementation at the Former Fuller O'Brien Facility (currently Britannia East Grand):

- Methane Mitigation Plan, Britannia East Grand Development, Phase II (Section A)
- Land Use Covenant Implementation and Enforcement Plan (Section B)

### **2.0 SITE DESCRIPTION**

The Britannia East Grand site (Site) is located on East Grand Avenue east of Haskins Way in South San Francisco, California (Figure 1). Slough SSF, LLC (Slough) is currently developing the Site for commercial use. Phase I development at the Site, consisting of Buildings 1, 3, 4, 5/6, Parking Structure A, and the Child Care Center in the northern portion of the Site, is substantially underway, with anticipated occupancy of a portion of Phase I beginning in late 2006.

Phase II development activities will be conducted in the southern portion of the Site and includes the construction of Buildings 2, 7, 8, 9, and Parking Structure B. Phase II consists of two parts, Phase II North (Buildings 2, 7, and 8) and Phase II South (Building 9 and Parking Structure B). As of the date of this document, Phase II construction of Building 2 and Parking Structure B has been initiated.

Figure 2 shows Phase I and Phase II areas, along with the location of Site buildings.

### **3.0 METHANE MITIGATION**

Soil gas investigations performed at the Site identified elevated methane gas concentrations (i.e., greater than 5 percent by volume in air) in localized areas of Phase II South (Building 9 and Parking Structure B). Due to the elevated concentrations of methane measured in these areas, mitigation and monitoring procedures for Phase II South are regulated by the Department

of Toxic Substances Control (DTSC). Based on the results of the soil gas testing performed, methane in soil gas beneath the proposed Parking Structure B and Building 9 is likely due to the decomposition of organic material present in the underlying soil.

A Methane Mitigation Plan (MMP) has been prepared by GeoSyntec Consultants, Inc. (Section A) for the Site.<sup>1</sup> The MMP presents the design of the Gas Monitoring and Control System (the System) that will be employed to address potential risks associated with methane at the Site.

The System will include components to monitor and control explosive and/or flammable gases that may accumulate beneath the building structures for the proposed Phase II development area. The objective of the MMP is to provide the basis of design and approach for the System, so that the System will provide a safe environment for the occupants of the proposed enclosed structures potentially affected by elevated concentrations of methane.

The MMP provides a description of the System, Construction Drawings, Technical Specifications, a Construction Quality Assurance (CQA) plan, along with an Operations, Maintenance, and Monitoring (OMM) plan. The System employs a reinforced concrete structural slab gas barrier, utility gas barriers, a passive gas extraction system, and a monitoring system to monitor the presence of subsurface gasses. The OMM plan outlines the procedures that are required to monitor and preserve the integrity of the System over time.

#### **4.0 LAND USE COVENANT IMPLEMENTATION AND ENFORCEMENT**

The DTSC and Slough will enter into a Covenant to Restrict Use of Property (Land Use Covenant) to impose restrictions on the use of the Site. These land use restrictions are the institutional controls required to limit exposure to current and future landowner(s) and/or user(s) and/or occupants and to maintain the effectiveness of the corrective action. These institutional controls are designed to limit exposure to any remaining hazardous waste(s) and to protect human health and the environment. DTSC will conduct annual inspections to ensure compliance with the land use restrictions. This Land Use Covenant does not apply to the Childcare Center site, which is located in the northwestern portion of the Site and will have a future address of 430 East Grand Avenue.

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<sup>1</sup> GeoSyntec Consultants, Inc., Methane Mitigation Plan, Britannia East Grand Development, Phase II, March 2006.

A draft of the Land Use Covenant Implementation and Enforcement Plan (LUCIE Plan, Section B) has been prepared by DTSC to summarize the land use covenant, including:

- Prohibited Uses and Activities
- Permitted Uses and Activities
- Non-Interference with Groundwater Monitoring Wells
- Property Cover
- Controls During Construction Activity
- Soil Management
- Access for DTSC
- Access for Implementing Operation and Maintenance of the Corrective Action
- Annual Inspection and Certification

## **SECTION A**

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# **Methane Mitigation Plan Britannia East Grand Development, Phase II**

**METHANE MITIGATION PLAN  
BRITANNIA EAST GRAND DEVELOPMENT  
PHASE II**

**SOUTH SAN FRANCISCO, CALIFORNIA**

Prepared for:

**Slough Estates USA, Inc.**  
444 North Michigan Avenue, Suite 3230  
Chicago, Illinois 60611

Prepared by:



**GeoSyntec Consultants**  
10875 Rancho Bernardo Road, Suite 200  
San Diego, California 92127  
(858) 674-6559

16 March 2006



16 March 2006

Slough Estates USA, Inc.  
c/o Mr. Bruce Heimbach  
Project Management Advisors, Inc.  
462 Stevens Avenue, Suite 106  
Solana Beach, CA 92075

Subject: Methane Mitigation Plan  
Britannia East Grand Development – Phase II  
South San Francisco, California

Dear Bruce:

GeoSyntec Consultants is pleased to provide Slough Estates USA, Inc. with the accompanying report presenting our findings and recommendations for the Methane Mitigation Plan for the Britannia East Grand Development – Phase II. The Methane Mitigation Plan includes Construction Drawings, Technical Specifications, a Quality Control Plan, and an Operations and Maintenance Plan for the methane control and monitoring system for the project. This plan was prepared in accordance with our proposal dated 2 September 2005 and existing Agreement.

If you have any questions or need further assistance, please contact the undersigned at (858) 674-6559.

Sincerely,

// Original Signed By //

Steven M. Fitzwilliam, R.C.E. 5323  
Senior Engineer

//Original Signed By //

Gregory T. Corcoran, R.C.E. 58876  
Associate



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Appendix D	Operation, Maintenance, and Monitoring Plan
Appendix E	Design Calculations

## **1. INTRODUCTION**

### **1.1 Terms of Reference**

This report presents the proposed plan for the mitigation of methane gas that has been encountered within the subsurface at the proposed Britannia East Grand Phase II development in South San Francisco, California. This report was prepared by Mr. Steve Fitzwilliam, G.E., and has been reviewed by Mr. Gregory T. Corcoran, P.E., both of GeoSyntec Consultants (GeoSyntec), in accordance with the peer review policies of the firm.

### **1.2 Site Description**

The Britannia East Grand, Phase II site (Site) is located on East Grand Avenue east of Haskins Way in South San Francisco, California (Figure 1). Slough Estates USA, Inc. (Slough) is in the process of preparing plans for development of the Site for commercial use. The Phase I development, consisting of Buildings 1, 3, 4, 5/6, Parking Structure A and the Child Care Center, is in the process of being constructed at the north end of a graded commercial business park. The Phase II development will include the construction of Buildings 2, 7, 8, 9, and Parking Structure B in the southern portion of the Site. Phase II consists of two parts, Phase II North (Buildings 2, 7, and 8) and Phase II South (Building 9 and Parking Structure B) (Figure 2).

### **1.3 Existing Gas Conditions**

Iris Environmental (IRIS, 2004a and 2004b) and GeoSyntec (GeoSyntec, 2004a) have previously performed separate soil gas investigations at the Site in the Fall of 2004. The investigation consisted of installing soil gas probes, collecting samples of soil gas from the probes, and analyzing the collected samples for various constituents, including methane, nitrogen, oxygen, carbon dioxide, and volatile organic compounds (VOCs). Based on the results of these soil gas surveys, methane gas was detected in all but one of the samples collected by IRIS and GeoSyntec. The Phase I and Phase II North building pad areas were found to have methane gas concentration less than 0.5% by volume (GeoSyntec, 2004a). The Phase II South building pad areas were found to have methane gas concentrations that exceeded 5% by volume. The methane mitigation

and monitoring for Phase II North is an extension of the methods and procedures implemented for the Phase I development. This methane mitigation and monitoring is precautionary. The mitigation and monitoring procedures for Phase II South (Building 9 and Parking Structure B) is regulated by the Department of Toxic Substances Control (DTSC) due to the higher measured concentrations of methane in this area.

GeoSyntec issued a letter to the DTSC (GeoSyntec, 2004a), which presented conclusions regarding the possible gas sources at the site. Based on soil gas testing performed for the project site and subsequent engineering evaluations, methane in the northern portion of the site appears to be under aeration limited conditions, which are most likely from decomposition of organics within the soil. Methane in the southern portion of the site, specifically under Building 9 and Parking Structure B, appear to be under methanogenic conditions indicative of methane production. Methane in soil gas beneath the proposed Parking Structure B and Building 9 is likely due to the decomposition of organics in the soil.

#### **1.4      Project Scope**

This Methane Mitigation Plan presents the design of the Gas Monitoring and Control System (System) that will be employed to address potential risks associated with methane at the Site. The System will include components to monitor and control explosive and/or flammable gases that may accumulate beneath the building structures for the proposed Phase II development at the Site. The objective of this report is to provide the basis of design and approach for the System to provide a safe environment for the occupants of the proposed enclosed structures on Site.

This report provides a description of the System, Construction Drawings (Appendix A), Technical Specifications (Appendix B), a Construction Quality Assurance (CQA) plan (Appendix C), and an Operations, Maintenance, and Monitoring (OMM) Plan (Appendix D). The OMM plan outlines the procedures that are required to monitor and preserve the integrity of the System.

## **2. DESIGN REQUIREMENTS**

### **2.1 Potential Risks**

The potential risks associated with methane gas are fire and/or explosion. When methane is present in air at concentrations between 5% and 15% of the total gas volume, a fire and/or explosion can occur. In air, 5% methane is considered to be the Lower Explosive Limit (LEL) and 15% methane is considered the Upper Explosive Limit (UEL). If the methane is unconfined, mixed with oxygen, and exposed to an ignition source, a fire may occur. If methane is confined, mixed with oxygen, and exposed to an ignition source, an explosion may occur.

As discussed in section 1.3, methane gas has been detected in the subsurface at the Site. Therefore, the potential for methane to migrate into proposed buildings to be constructed at the Site needs to be controlled to mitigate the associated risks of fire and explosion.

### **2.2 Design Objective**

Based on the potential risks, the following design objective was established for the design and implementation of a gas monitoring and control system at the Site:

- The detected concentrations of methane in the gas extraction layer beneath the reinforced concrete structural slab shall be less than the LEL (5% by volume).

### **3. GAS CONTROL AND MONITORING SYSTEM DESIGN**

#### **3.1 Introduction**

The purpose for the installation of the System focuses on minimizing potential fire and explosion risks to humans due to potential methane accumulation in the enclosed portions of the structures. The System employs a reinforced concrete structural slab gas barrier, utility gas barriers, a gas extraction system, and a subsurface gas monitoring system. In the case of the enclosed portions of Parking Structure B and Building 9 (Phase II South), a geomembrane barrier will be installed to supplement the reinforced concrete structural slab gas barrier.

The gas monitoring system will provide a means to manually monitor for the presence of explosive gases beneath the buildings. The gas extraction system will provide a means to passively extract gases that could potentially accumulate beneath the buildings. The gas extraction system has been designed to accommodate the use of blowers, if needed.

#### **3.2 Gas Control System**

A methane gas control system will be incorporated into the proposed development. The gas control system will be comprised of gas barriers and gas extraction and monitoring systems. Each of these components is described below.

##### **3.2.1 Gas Barrier**

The purpose of the gas barrier is to control the migration of methane gas into the proposed buildings. The ground floor of the buildings will have a reinforced concrete structural slab, which will function as the gas barrier. We understand that the thickness and reinforcement within the concrete barrier at this development will minimize full depth cracking of the barrier. This will serve to minimize the potential for gas migration into the proposed structure. Due to elevated methane concentrations, Parking Structure B and Building 9 (Phase II South) will require installation of a geomembrane gas barrier to supplement the reinforced concrete gas barrier under the enclosed areas of the parking structure.

A continuous geomembrane gas barrier (Figure 3) beneath the enclosed areas of Parking Structure B and Building 9 will be required and will consist of a 100-mil thick cold spray-applied geomembrane (e.g. Liquid Boot) on top of a nonwoven heat bonded carrier geotextile or thin film carrier geomembrane. The geomembrane is separated from the reinforced concrete structural slab by a cushion geotextile designed to prevent damage to the geomembrane from installation of the concrete and associated steel reinforcement as determined by the calculation “*Geotextile Puncture Protection of Liquid Boot*,” (Appendix E). In addition, the geomembrane gas barrier will be adhered to both the cushion geotextile and the concrete structural slab, thereby minimizing the potential for the geomembrane to sag in areas where soil settlement may create voids between the subgrade soil and the concrete structural slab. Utilities and other subsurface piping will be supported by hangers extending through the geomembrane gas barrier into the structural slab, thereby providing additional attachment for the geomembrane gas barrier. Pipe hanger, reinforcement, and utility pipe penetrations will be sealed at the geomembrane gas barrier penetration through the use of “boots,” as shown on Detail 14 Sheet 6 (Appendix A).

In addition, utility corridors will require installation of subsurface cut-off features that encompass the width and depth of the utility trench and have a length of 2 feet as shown on the Detail 9 Sheet 6 in Appendix A. The subsurface cut-off features will be comprised of a cement slurry (2 sack mix) containing 2% bentonite. Subsurface dry utilities entering the buildings (e.g. telephone and electrical conduit) will require the installation of a silicone sealant within the conduit at the point of entry into the building as noted on Detail 9 on Sheet 6 (Appendix A). Non-pressurized utilities (e.g. sewer, storm drains, etc.) may require the use of wet “P-traps” and/or air tight piping (e.g. solvent joined polyvinyl chloride (PVC)) to minimize gas migration into the pipes and then into the proposed buildings.

### 3.2.2 Gas Extraction System

The gas extraction system will contain two types of pipes: air inlet pipes and gas extraction pipes. The two types of pipes will be placed parallel to one another in an alternating pattern between extraction and air inlet pipes across the footprint of the building area to be covered, with the extraction pipes imposing a vacuum and the air inlet pipes set at atmospheric pressure. This will provide a “sweeping” effect within the continuous sand or aggregate layer, which will remove gases that have accumulated from within the sand or aggregate layer, as conceptually illustrated in Figure 4. A 6-inch layer of aggregate replaces the 3 inches of sand over the visqueen moisture barrier, over 3 inches of aggregate where a geomembrane gas barrier is specified (Phase II South).

Subsurface gases will be collected through the sand or aggregate layer and perforated pipes, as shown on Sheets 1 through 5 (Appendix A), which will convey the gases to solid wall header pipes and to the roofline of the proposed buildings, where they will be vented to the atmosphere. Air inlet and gas extraction pipe openings will be placed a minimum of 10 feet from heating, ventilation, and air conditioning (HVAC) intakes, building openings (vents, windows, doors, etc.), and above grade, Sheet 6 (Appendix A). A single extraction riser pipe per building will be required to convey collected gases to the roofline, while a single air inlet riser pipe can be provided a minimum of 10 feet above surface level in an architecturally acceptable location. A wind-driven turbine will be attached to the top of the gas extraction riser pipe to provide the vacuum to passively extract the gases from the sand or aggregate layer, Detail 15 Sheet 6 (Appendix A). Although no blowers are planned to be used initially, the system is designed to accommodate their use if active extraction becomes necessary in the future.

The gas extraction system beneath the proposed buildings will be comprised of a 2-inch diameter, Schedule 40, perforated and solid wall PVC pipes designed to resist damage due to crushing. The 2-inch pipe will be installed in plan locations as shown on Sheets 1 through 5 (Appendix A). The PVC pipes will be placed within a minimum 3-inch thick layer of sand directly underlying the concrete structural slab gas barrier for Buildings 2, 7, and 8 as shown on Detail 1, Sheet 6 (Appendix A), and within a minimum 3-inch thick layer of aggregate beneath the geomembrane underlying the

structural slab for the enclosed portions of Parking Structure B and Building 9 as shown on Detail 2, Sheet 6 (Appendix A).

Wind-driven turbine ventilators will be used to help induce the vacuum needed to evacuate subsurface vapors. The ventilators will induce pressure gradients within the sand or aggregate layer such that the extraction pipes will intake air predominantly from this extraction layer. Additional ventilation assistance will be provided by diurnal changes in temperature and barometric pressure.

The solid wall gas extraction and air inlet pipes will be supported from above by corrosion resistant (stainless steel, plastic, or other) pipe hangers spaced approximately every 8 feet attached to the concrete structural slab as determined in the calculation package "*Pipe Hanger Design*" (Appendix E). These pipe hangers are designed to minimize pipe deflection potential for sagging and trapping water. The perforated gas extraction and air inlet pipes will be supported by pipe hangers spaced approximately every 10 feet, to limit sagging as the perforated pipe will drain. Additional pipe hangers will be placed at either end of pipe crossings and at grade beam crossings.

### **3.3 Subsurface Monitoring**

Gas monitoring probes will be installed in strategic areas beneath the reinforced concrete structural slab and/or geomembrane gas barrier. Details 7 and 8, Sheet 6 (Appendix A) illustrates the subsurface monitoring probe detail, and Sheets 1 through 5 (Appendix A) illustrate plan locations of subsurface monitoring and preliminary vault locations. Gas samples will be collected from the gas monitoring probes and analyzed using a calibrated field instrument (e.g. combustible gas indicator, GEM 2000 Landfill Gas Meter) to analyze subsurface explosive gas concentrations and to identify potential gas concentration trends. If detected methane gas concentrations are measured above 100% LEL, the monitoring equipment will be checked to ensure that the readings are accurate and that the gas concentrations measured accurately represent the conditions beneath the structural slab. If the measured concentrations are concluded to be accurate and representative, the system will be upgraded with the addition of a blower to actively extract gases from beneath the buildings. Monitoring should commence once the building framing and shell of the building have been

completed (i.e. an enclosed structure has been created). Monitoring for Building 9 and Parking Structure B (Phase II South) will occur weekly for the first month, monthly for the first quarter, and quarterly thereafter allowing for modifications based on the results of sampling. Monitoring for Buildings 2, 7, and 8 (Phase II North) will occur quarterly for the first year. A letter to the DTSC reporting the results of the Phase II monitoring will be prepared and submitted following the first month, the first quarter, and the first year of monitoring.

Monitoring probes will consist of individual ½-inch diameter, Schedule 40 PVC piping running from discreet sample locations beneath the proposed buildings to external, surface mounted, traffic rated vaults, Details 7 and 8 Sheet 6 (Appendix A). A labcock valve will be included at the end of each monitoring probe to facilitate sample collection.

Upon completion of 4 consecutive quarterly sampling events, the data should be assessed for each individual building. If the data from the most recent 4 quarterly sampling events for an individual building indicate that explosive gas concentrations are consistently lower than 25% of the LEL, reduce sampling to annual for the specific building only. If data indicates that concentrations in any single monitoring probe exceed 25% of the LEL, continue quarterly sampling in each monitoring probe associated with the building until the above criteria can be met and the monitoring frequency lowered.

Similarly, we recommend that upon completion of 4 consecutive annual sampling events, the data should be assessed from each individual building. If the data from the most recent 4 annual sampling events for an individual building indicate that explosive gas concentrations are consistently lower than 5% of the LEL, perform an evaluation, by a qualified registered professional engineer licensed in the State of California, of the data to assess the ability to cease monitoring. If data indicates that concentrations in any single monitoring probe exceed 5% of the LEL, continue annual sampling in each monitoring probe associated with the building until the above criteria can be met and the monitoring frequency lowered.

If methane gas is routinely detected at concentrations exceeding the LEL, the passive system may need to be upgraded with the addition of a blower to actively extract gases from beneath the buildings.

A diagram summarizing the monitoring procedure described above for the Britannia East Grand project is presented in the Operations, Maintenance, & Monitoring Plan (Appendix D)

#### 4. SUMMARY AND CONCLUSIONS

Slough is extremely concerned about the health and safety of the occupants of the proposed BEG development. This Methane Mitigation Plan proposes an appropriate method and design for minimizing potential risks associated with methane gas. The design of the gas monitoring and control system includes the following:

- reinforced concrete structural slab gas barriers and utility trench gas barriers;
- geomembrane gas barrier beneath the enclosed portions of Parking Structure B and Building 9 (Phase II South);
- horizontal gas extraction system, including air inlet pipes and gas extraction pipes constructed of 2-in. diameter, Schedule 40 PVC pipe, and a passive wind-driven turbine; and
- sub-slab gas monitoring probes installed beneath the reinforced concrete structural slabs of each building;

When constructed and operated appropriately, the gas monitoring and control systems at the BEG site will be protective of the Site's occupants.

## 5. REFERENCES

GeoSyntec Consultants. 2004a. *Evaluation of Methane in Soil Gas, 450 E. Grand Avenue, South San Francisco, California*. December 9.

GeoSyntec Consultants. 2004b. *Methane Mitigation Plan, Britannia East Grand Development, South San Francisco, California*. November 23.

GeoSyntec Consultants. 2005. *Memorandum, Gas Monitoring and Control System, Britannia East Grand – Phase II*. September 7.

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